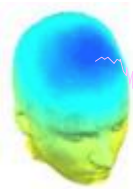
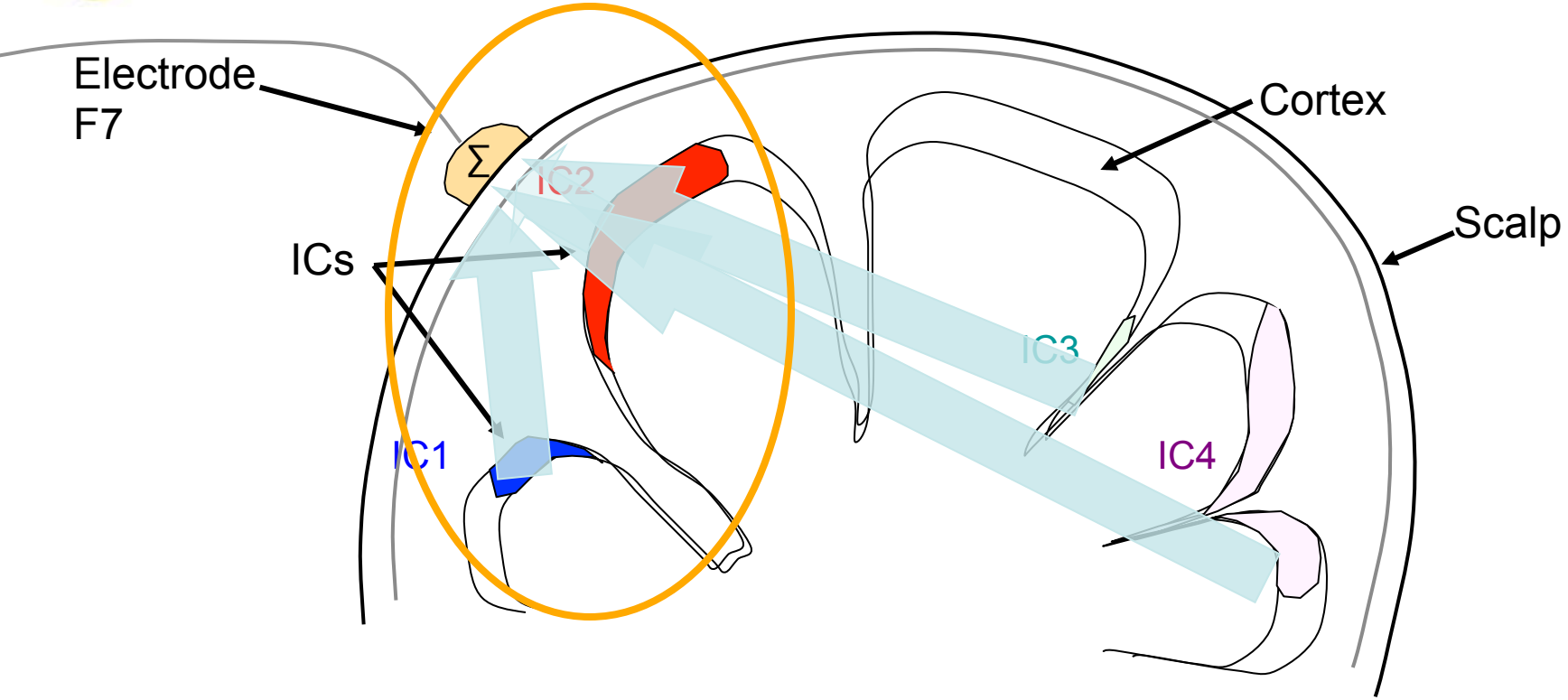
Why cluster independent components across subjects or sessions?



- ICA transforms the data from a channel basis (activity recorded at each channel)
  - to a component basis (activity computed at each IC).
- Normally, EEG researchers assume that electrode, say channel F7 == F7 == F7 ... in each subject and then ‘cluster‘ their data channel by channel ...
- But this is only *roughly* correct!

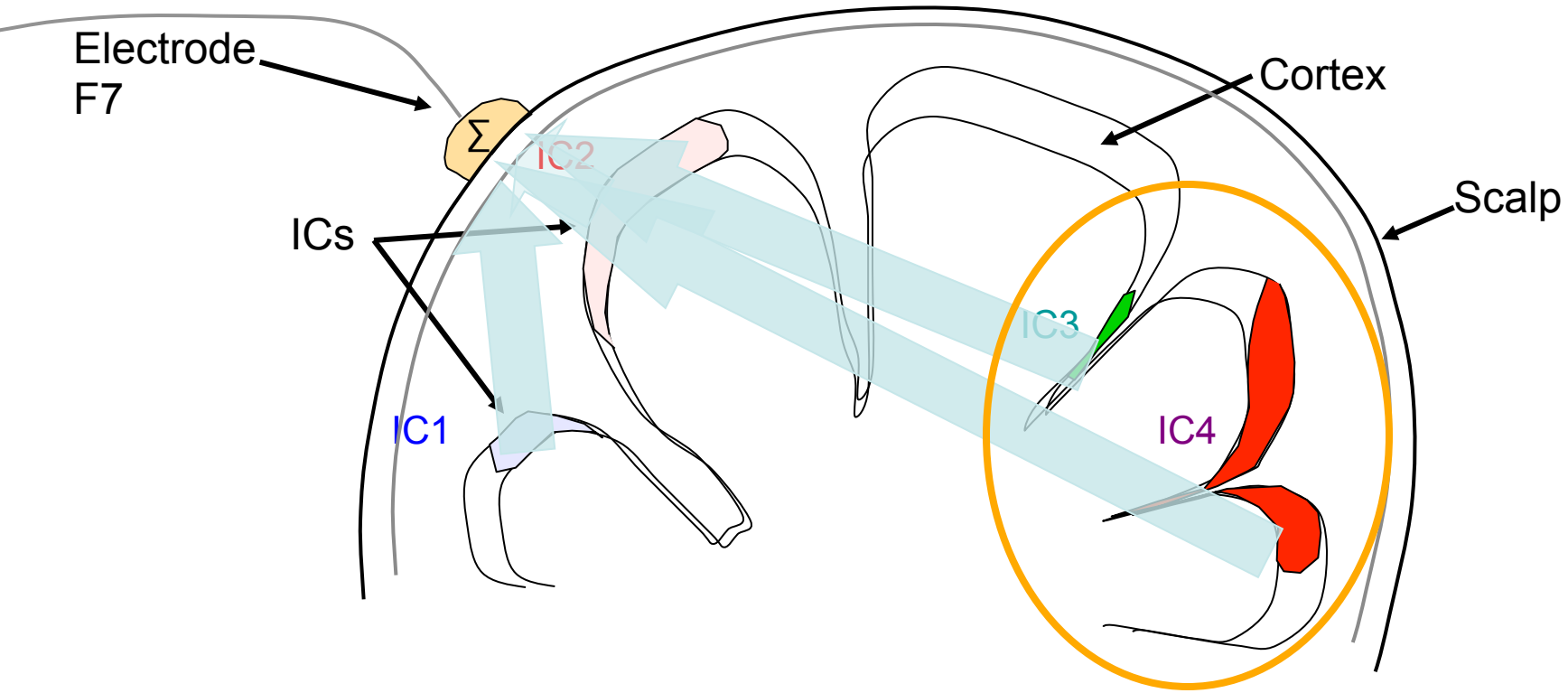
Makeig, 2007

Example: First Subject



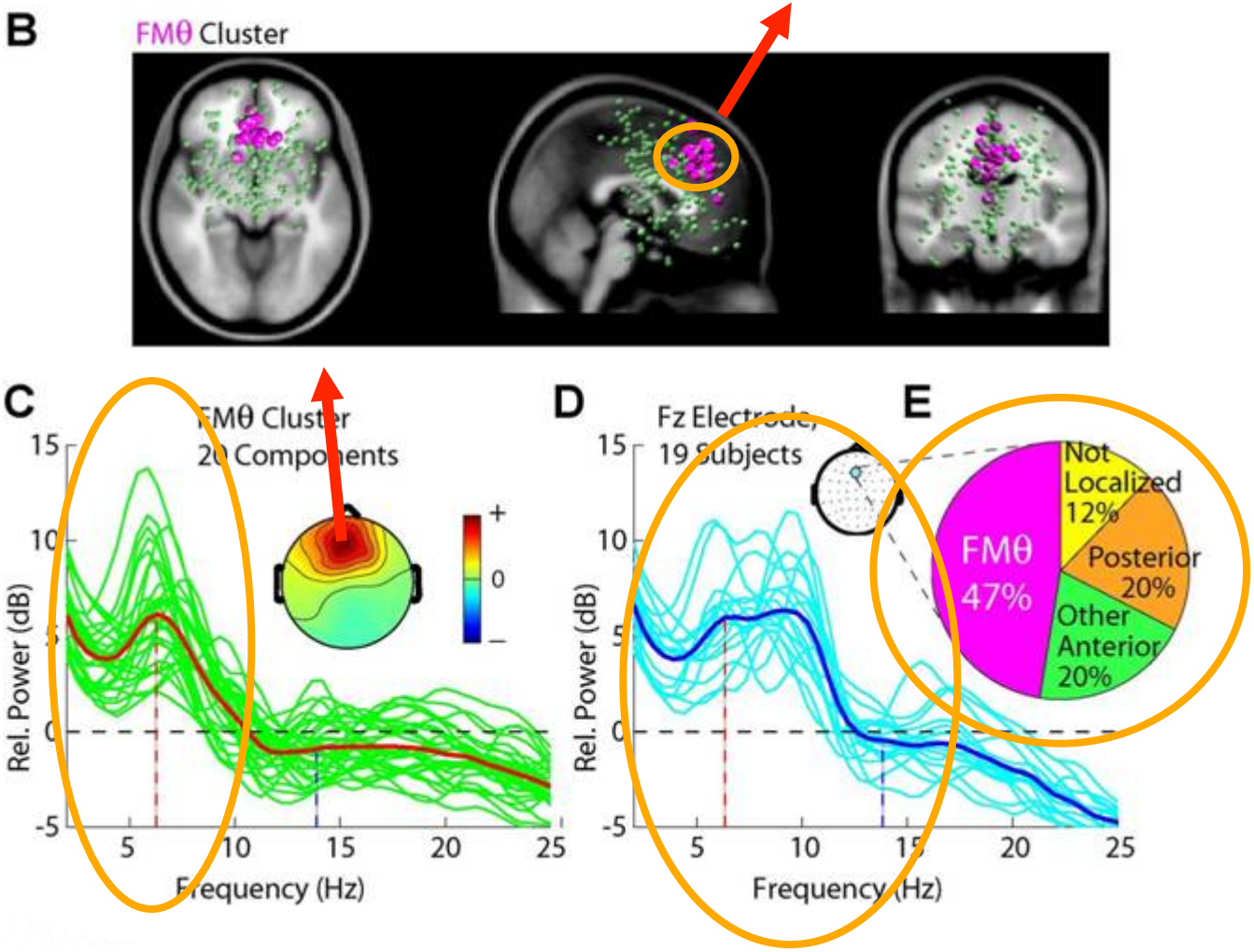
Makeig, 2005

Second Subject



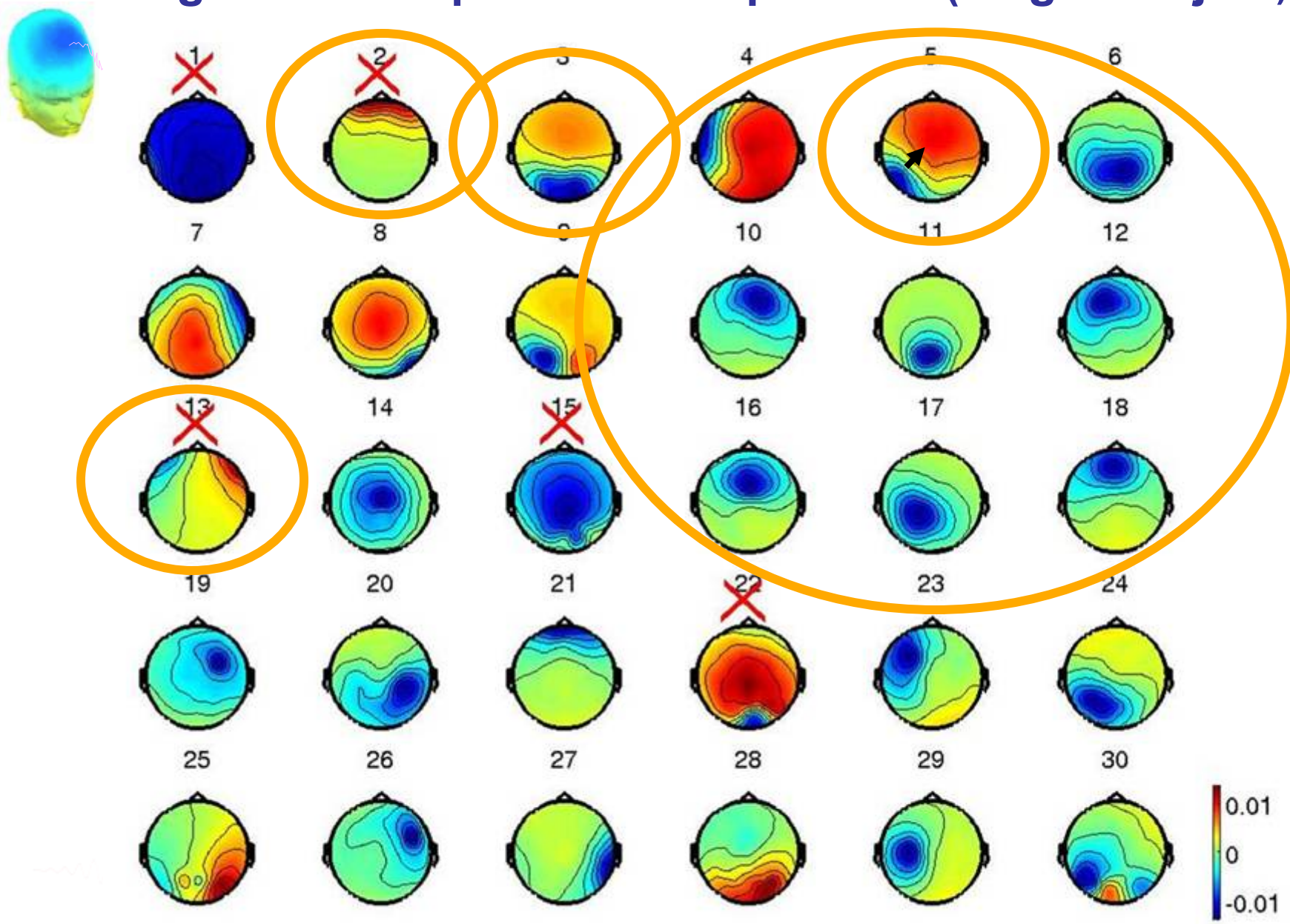
Makeig, 2005

A FM-theta cluster during working memory



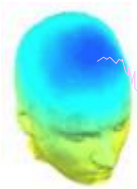
Onton et al., *NeuroImage* 2005

Largest 30 independent components (single subject)



Makeig, 2007

So how to cluster components?



The same problems hold for clustering independent components

Across Ss, components don't even have "the same" scalp maps!

→ Are "the same" components found across subjects?

- What should define "the same" (i.e., "component equivalence")?
  - Similar scalp maps?
  - Similar cortical or 3-D equivalent dipole locations?
  - Similar activity power spectra?
  - Similar ERPs?
  - Similar ERSPs?
  - Similar ITCs?
  - OR …, Similar ***combinations*** of the above?? …

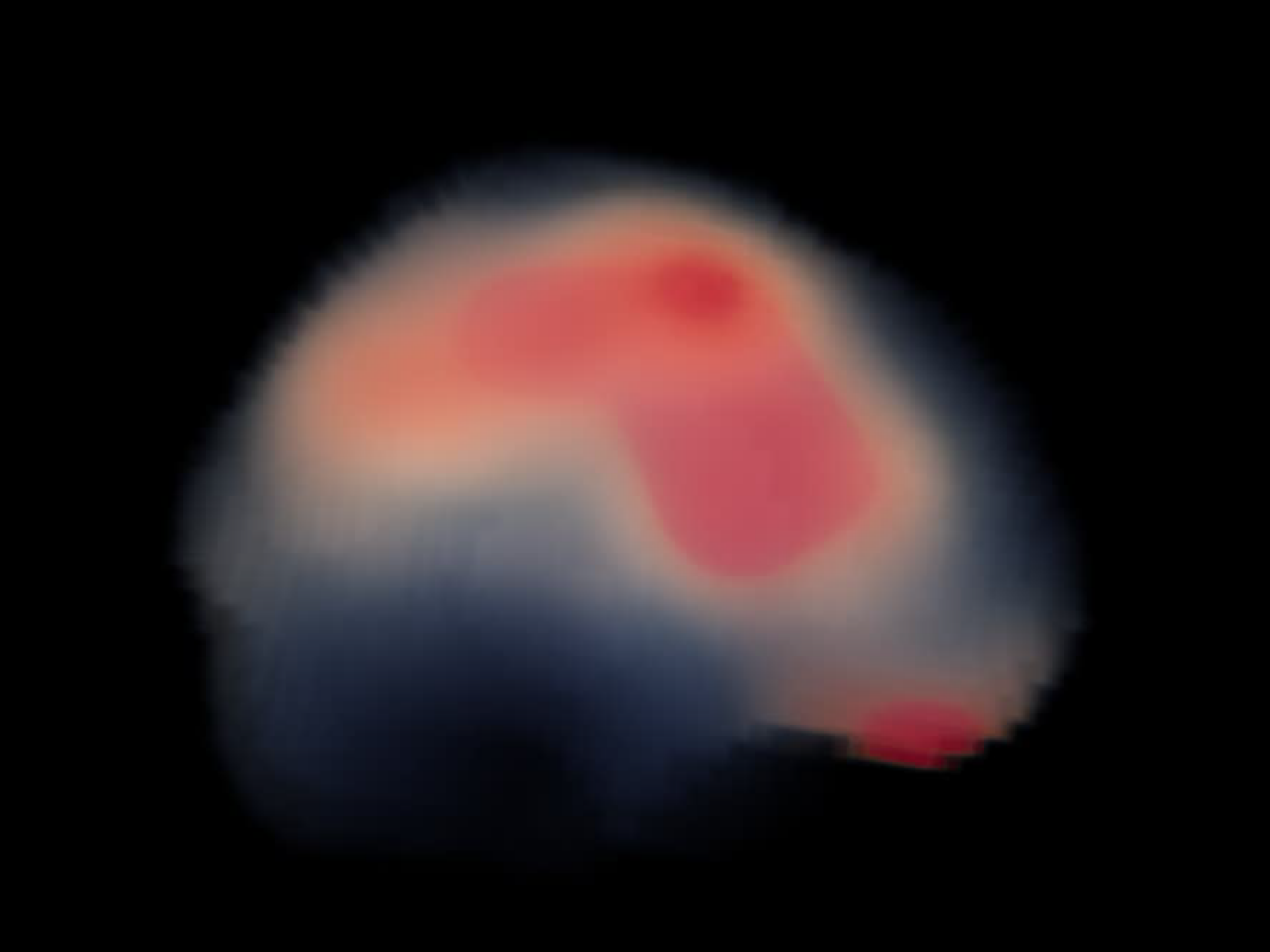
Makeig, 2007

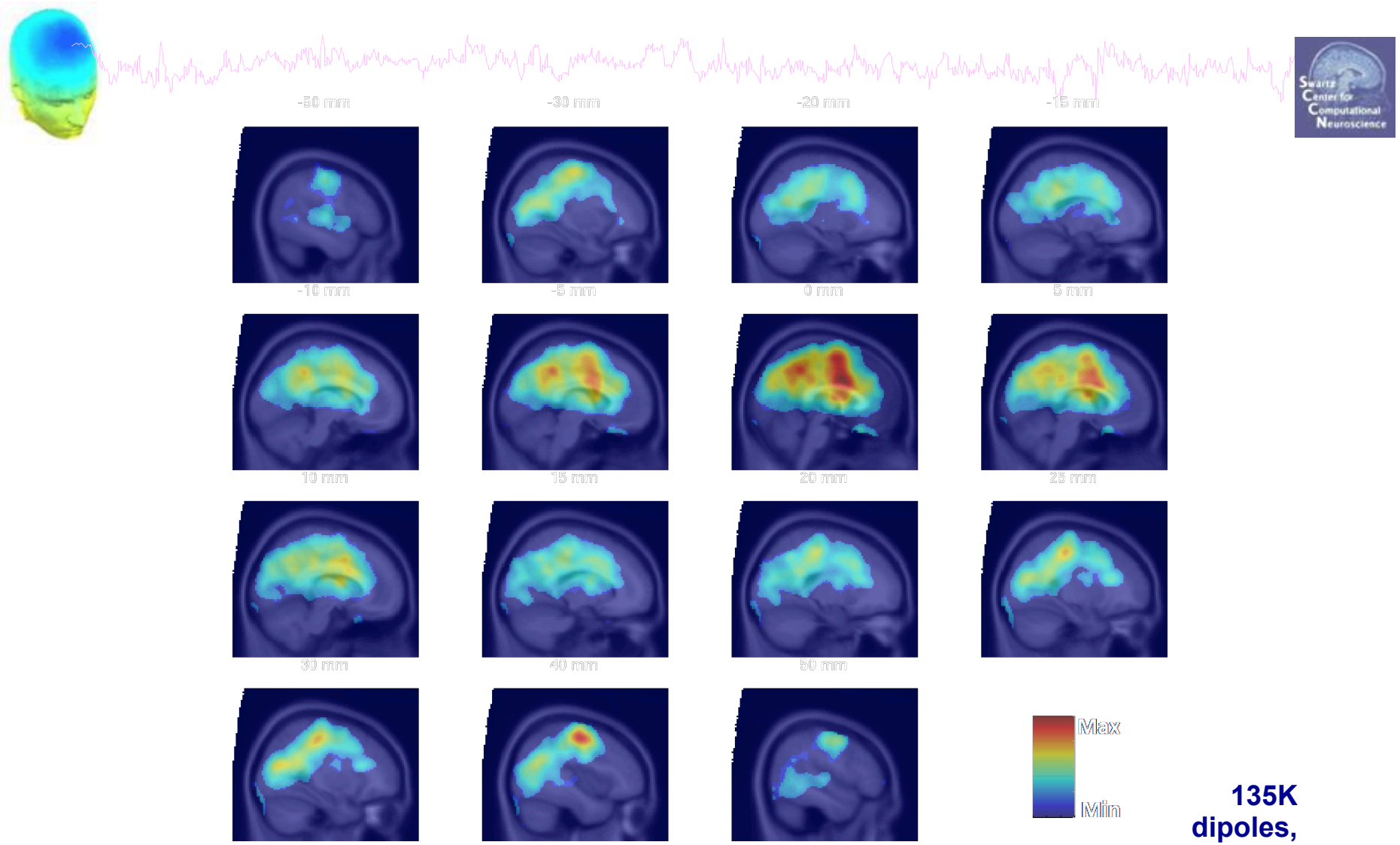
Does the spatial distribution of ICs depend on the task the subject performs?

i.e.

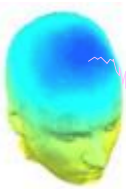
Do “the same” ICs (and IC clusters) appear for every task?

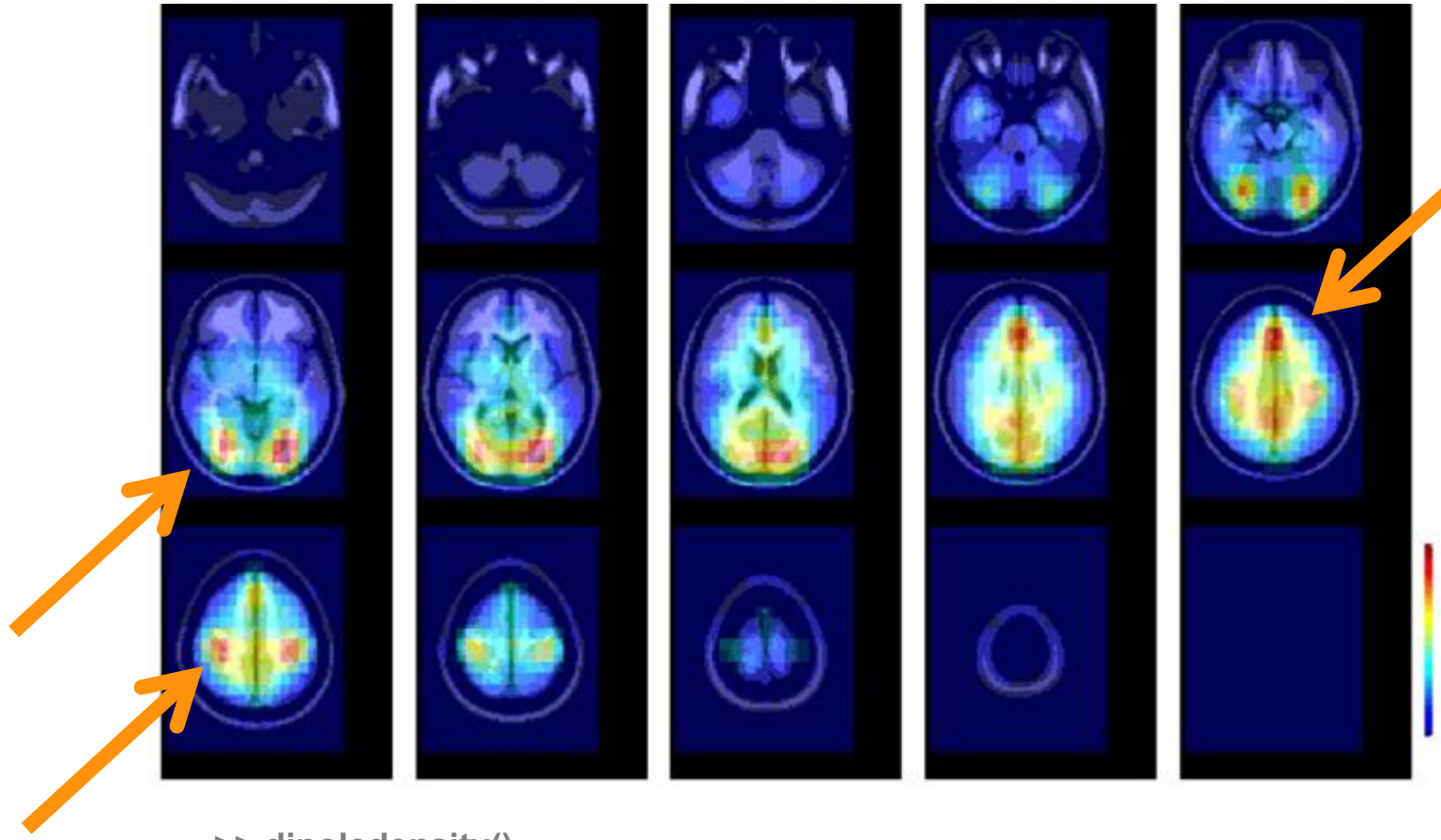
Makeig, 2007




-50 mm
-30 mm
-20 mm
-15 mm
-10 mm
-5 mm
0 mm
5 mm
10 mm
15 mm
20 mm
25 mm
30 mm
40 mm
50 mm
Max
Min
135K dipoles, p<.05

Equivalent dipole density



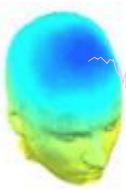


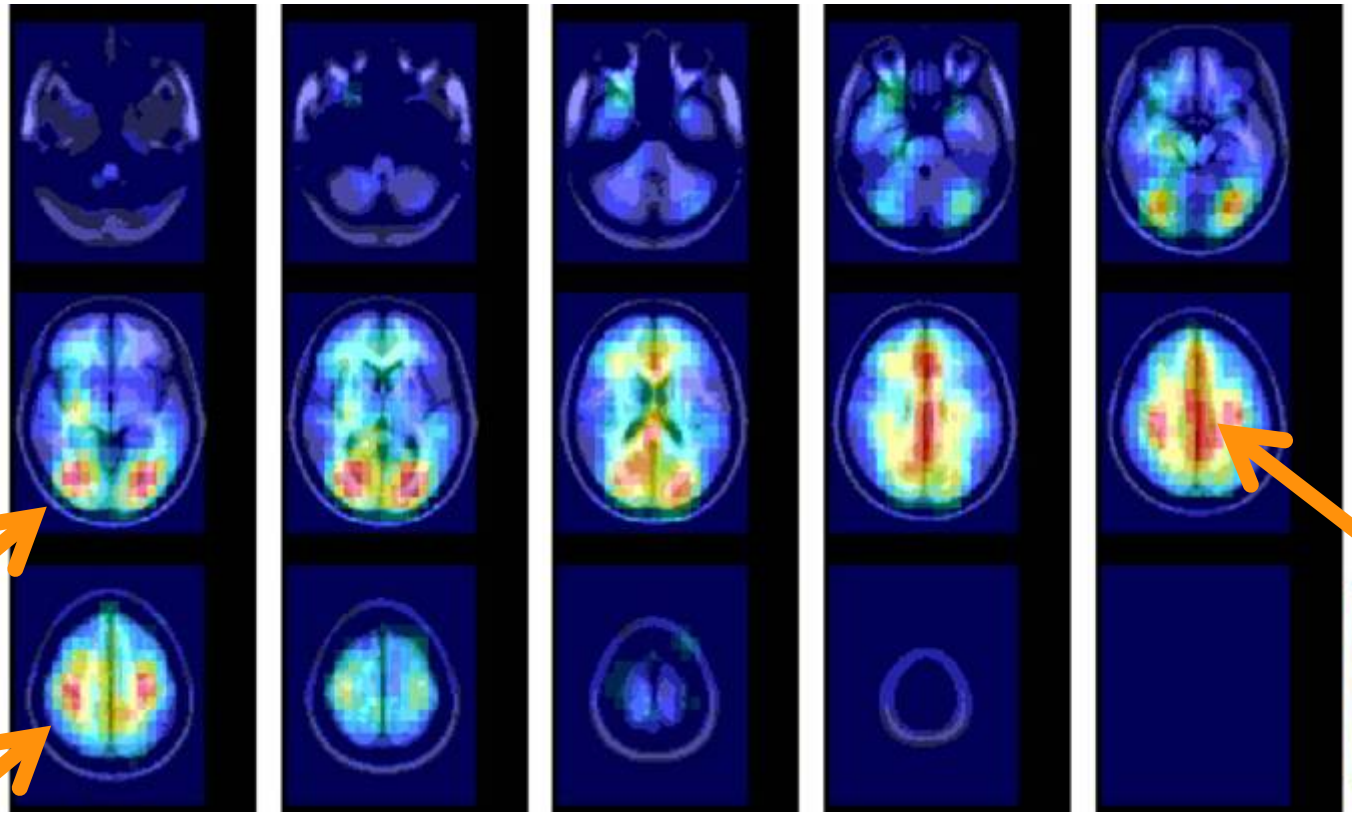
>> dipoledensity()

Onton et al., 2

Onton et al., ‘05

Equivalent dipole density





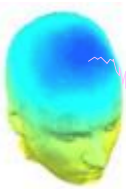
Letter twoback with feedback

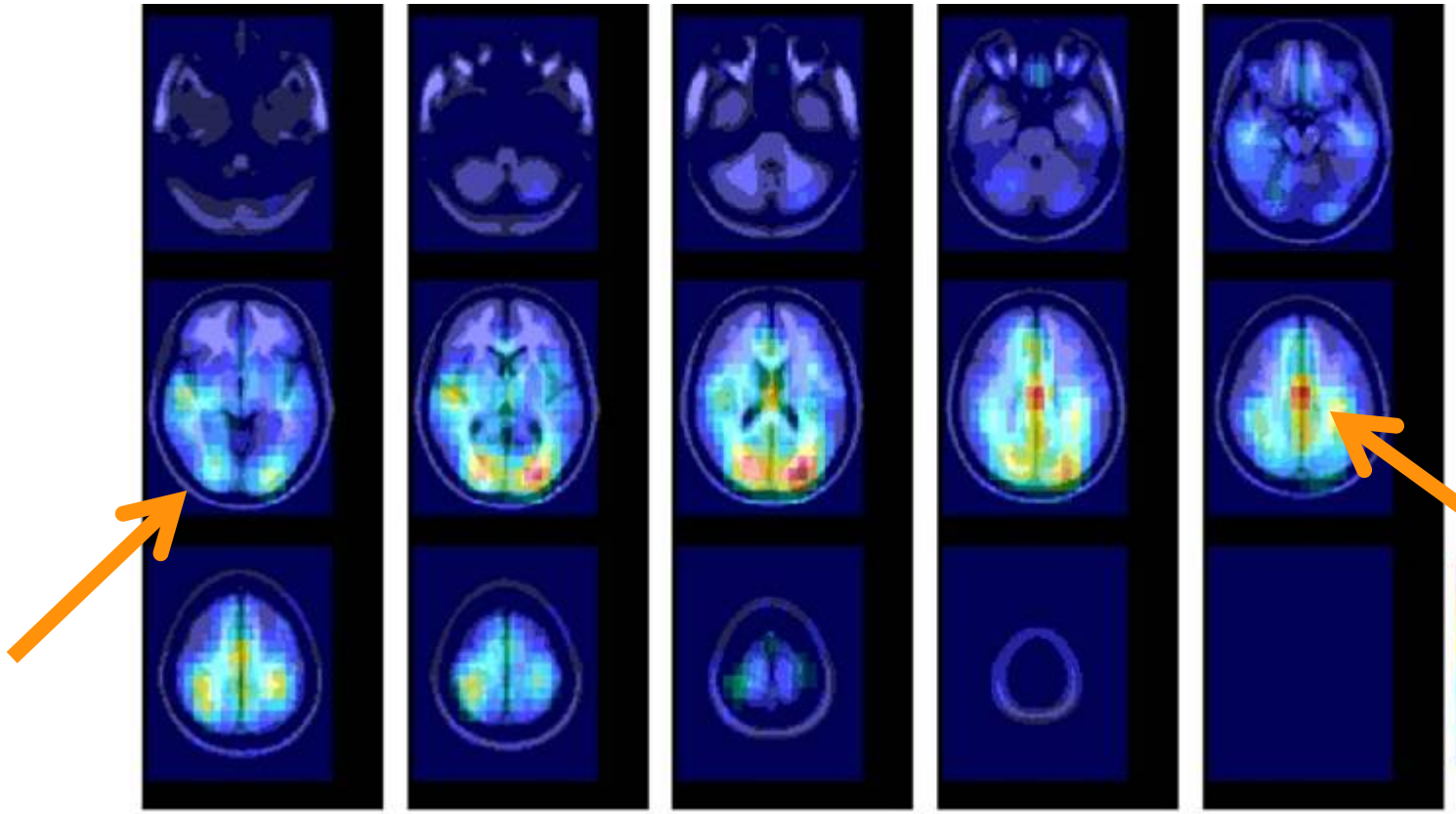
>> dipoledensity()

Onton et al., 2

Onton et al., '05

Equivalent dipole density

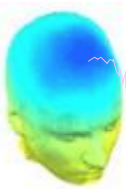


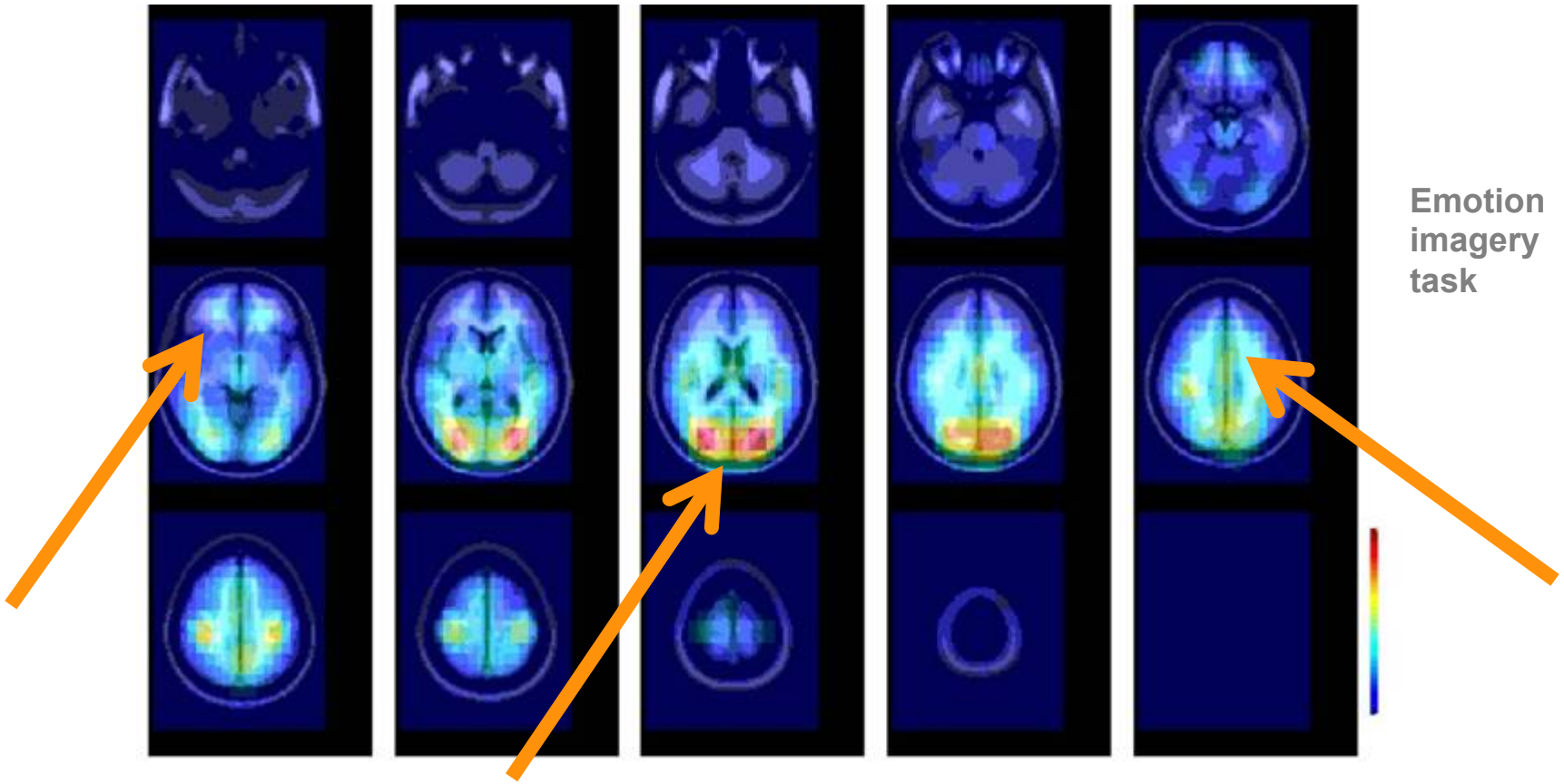


Auditory oddball plus novel sounds

>> dipoledensity()

Equivalent dipole density





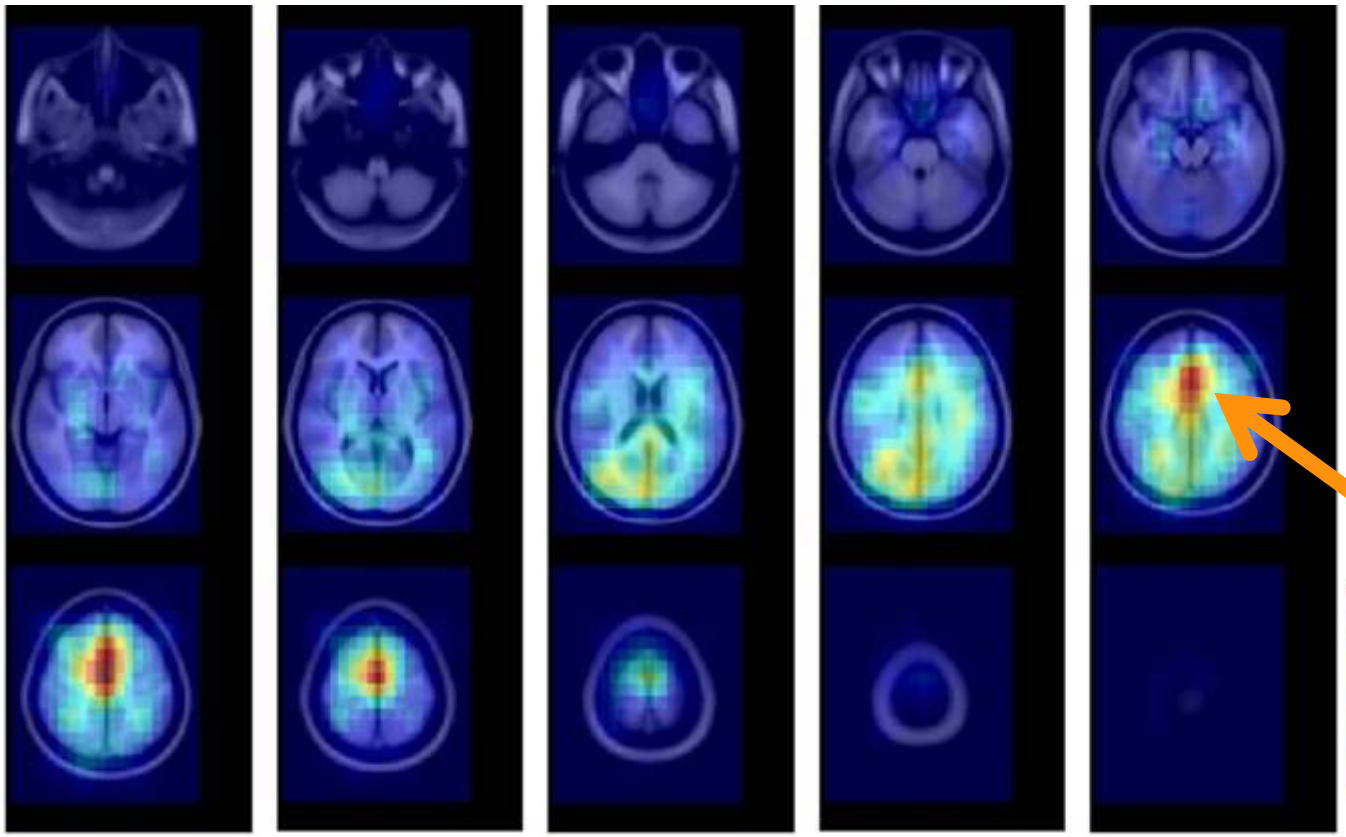
Emotion imagery task

>> dipoledensity()

Onton et al., 2

Onton et al., ‘05

Equivalent dipole density Exp I



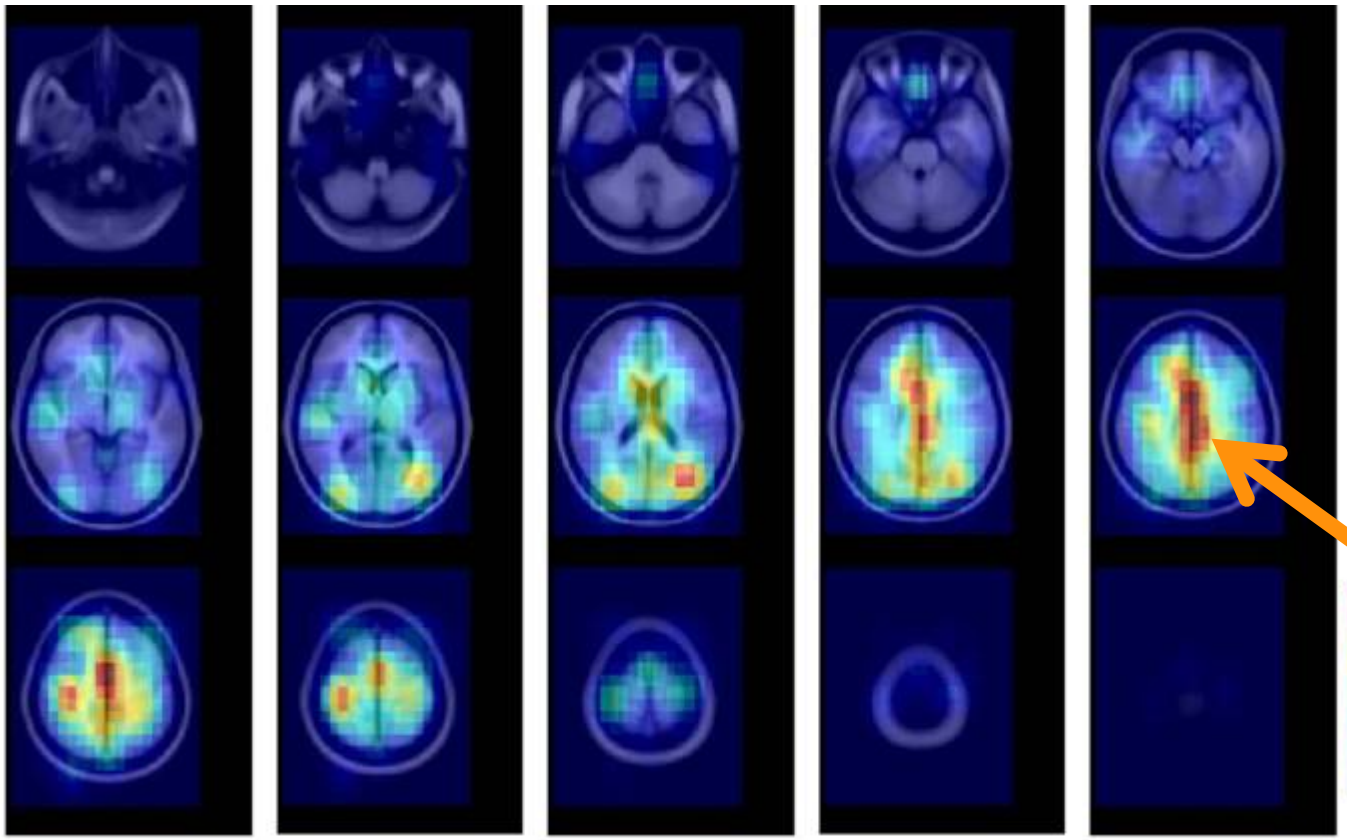
Word memory (old/new) task

>> dipoledensity()

Onton et al., 2

Onton et al., '05

Equivalent dipole density Exp II



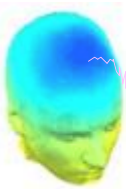
Visually cued button press task

>> dipoledensity()

Onton et al., 2

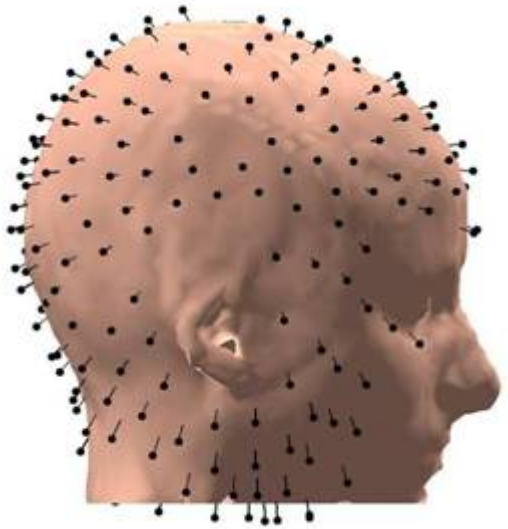
Onton et al., '05

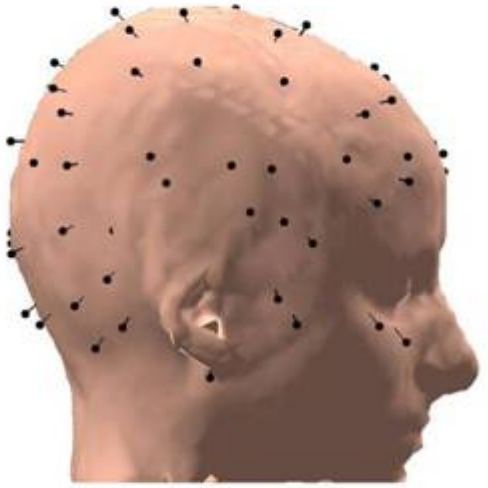
… Some caveats



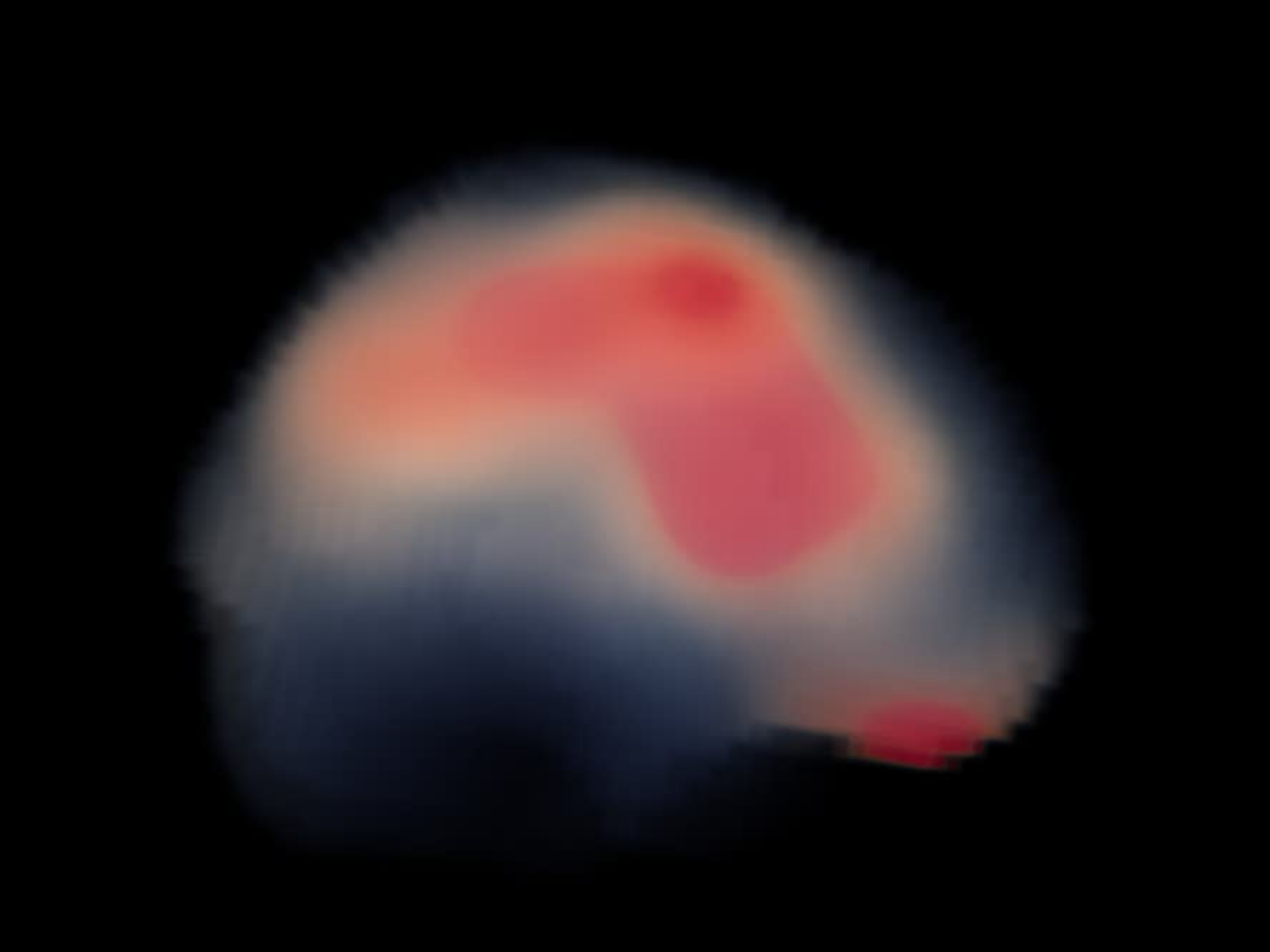
In this preliminary *dipoledensity()* study …

- The electrode locations were not individualized.
- MR images were not available → co-registration crude.
- Single versus dual-dipole model selection was subjective.
- Different electrode montages → possible location effects

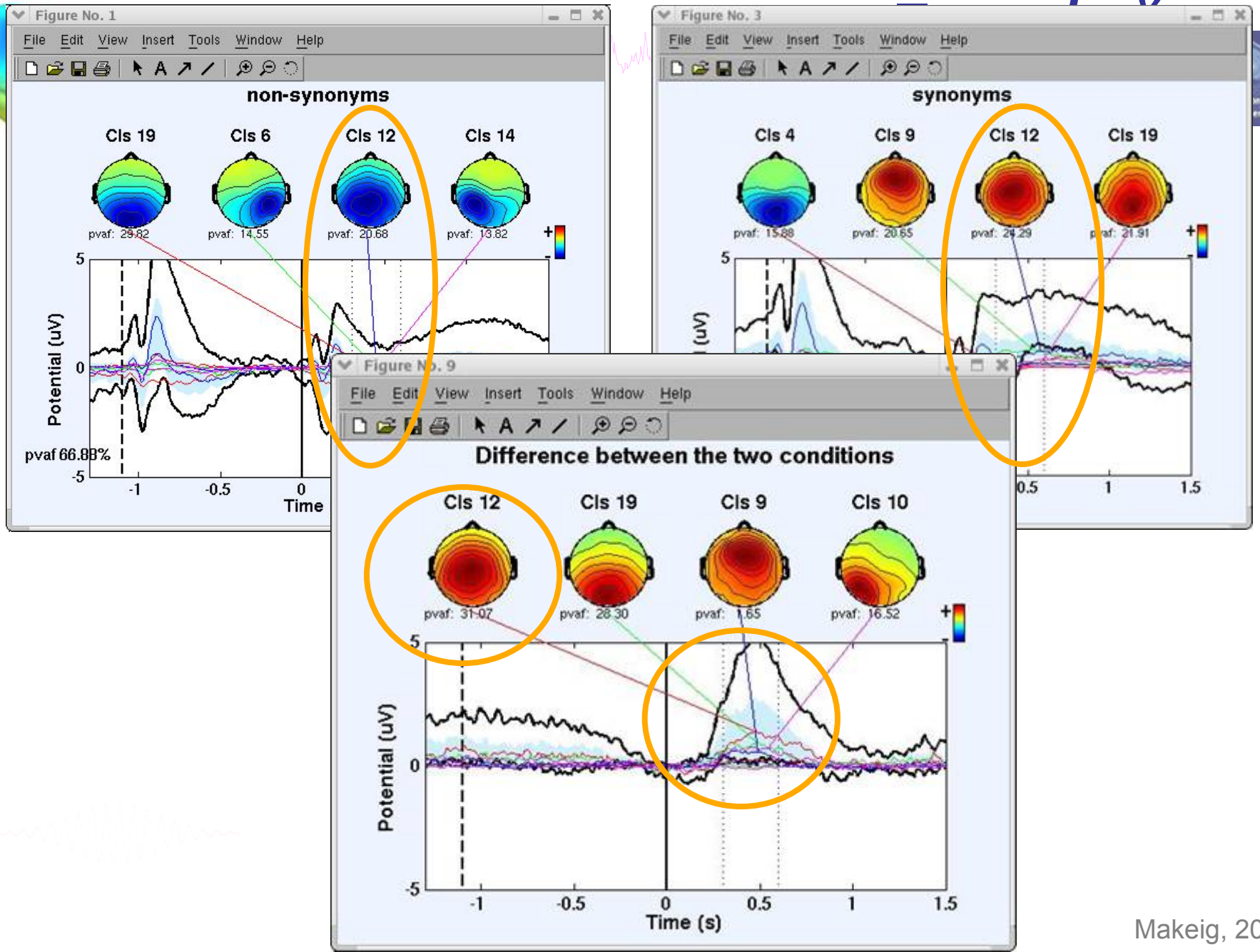




Onton, 2005

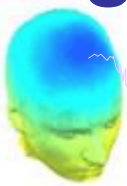


Cluster ERP contributions – *std_envtopo()*



Makeig, 2007

Should all subjects be included in each cluster?



Not all subjects contribute components to each cluster.

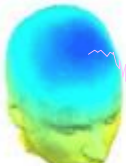
Why not?

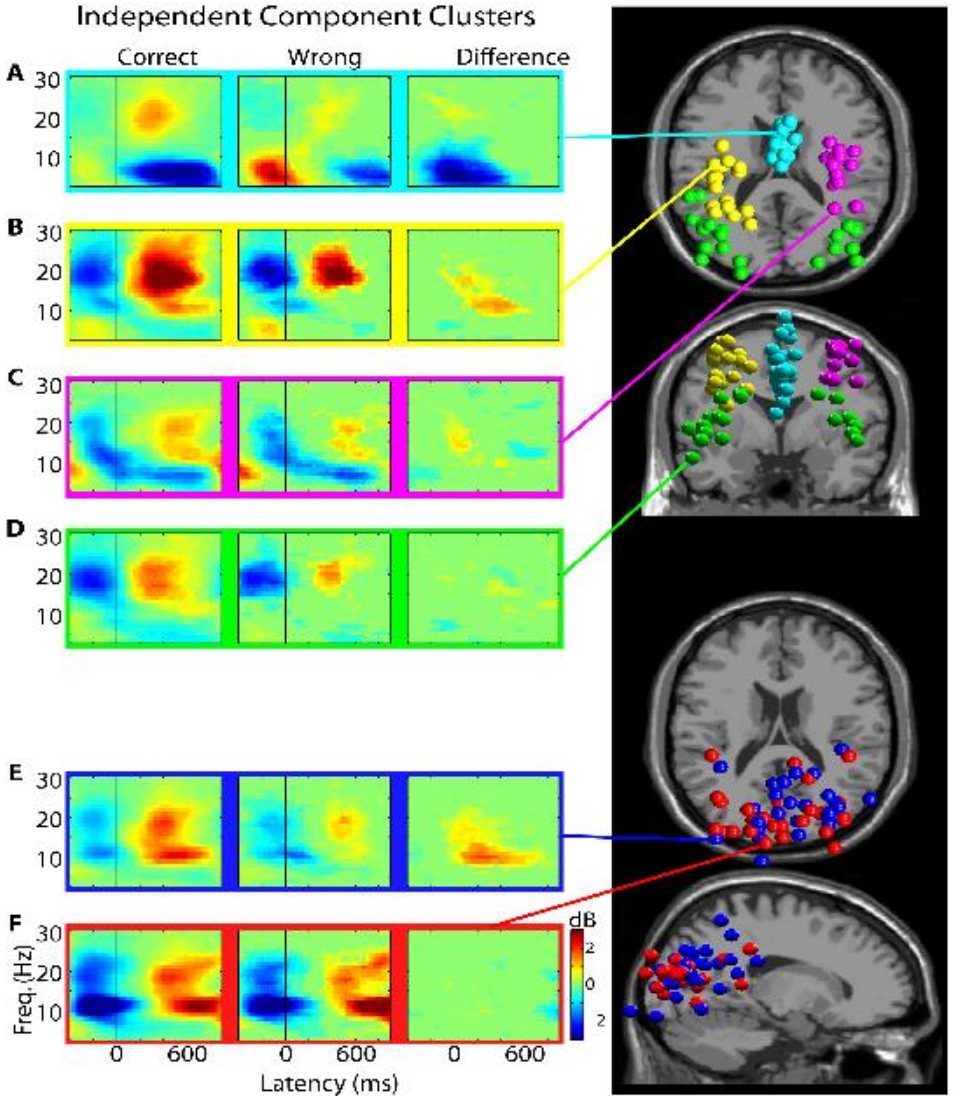
- Different numbers of artifact components
- Subject differences!?
- Is my subject group really just a Gaussian cloud

in ‘subject space’??

Makeig, 2007

Study IC Clustering





Sometime clusters are spatially separate AND have distinct responses.

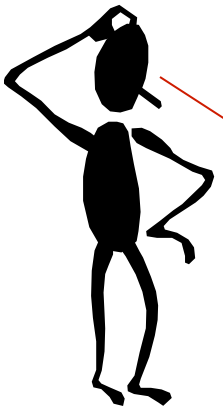
In other cases, they have similar responses or they overlap spatially.

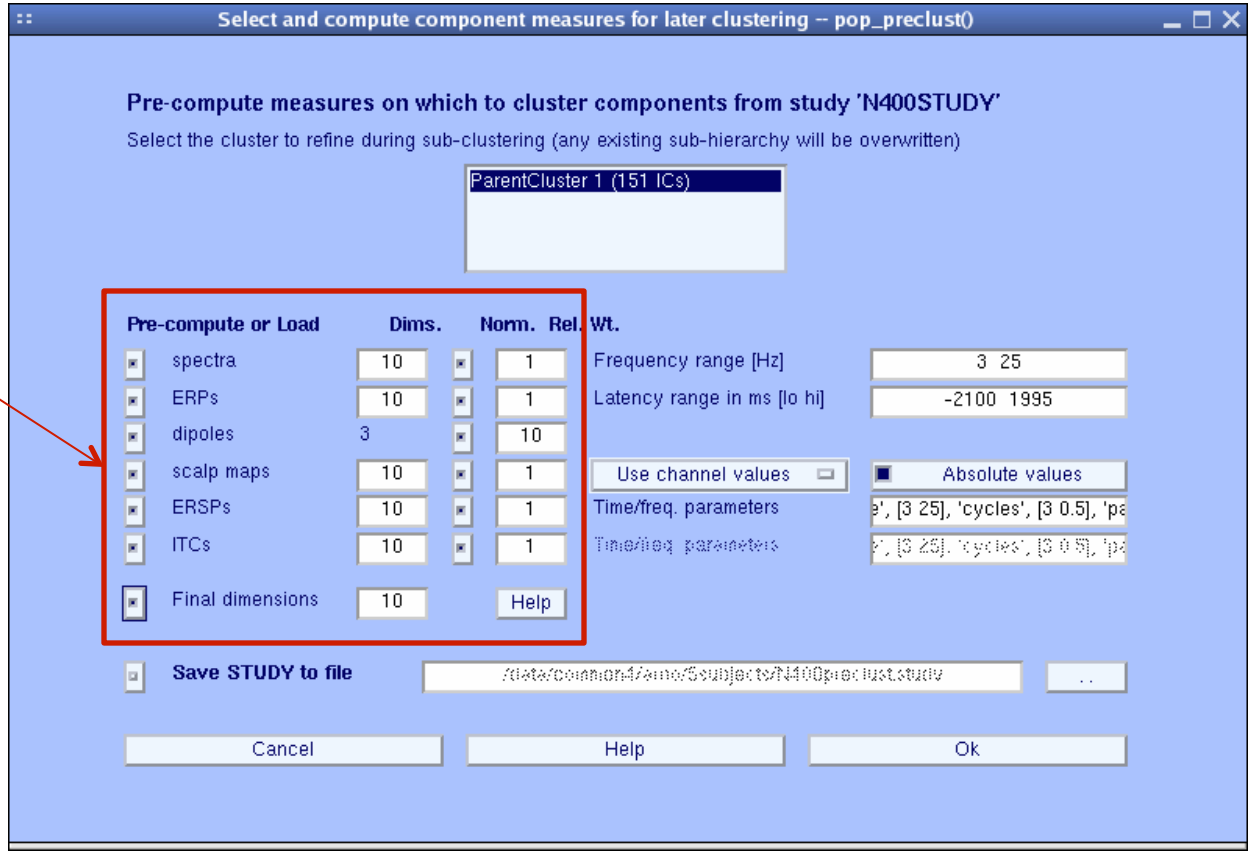
Onton & Makeig, 2007

Study IC Clustering: Practical Problems

Large parameter space problem: many different clustering solutions can be produced by changing parameters and measure subsets. Which one should we choose?

EEGLAB clustering has ~12 parameters

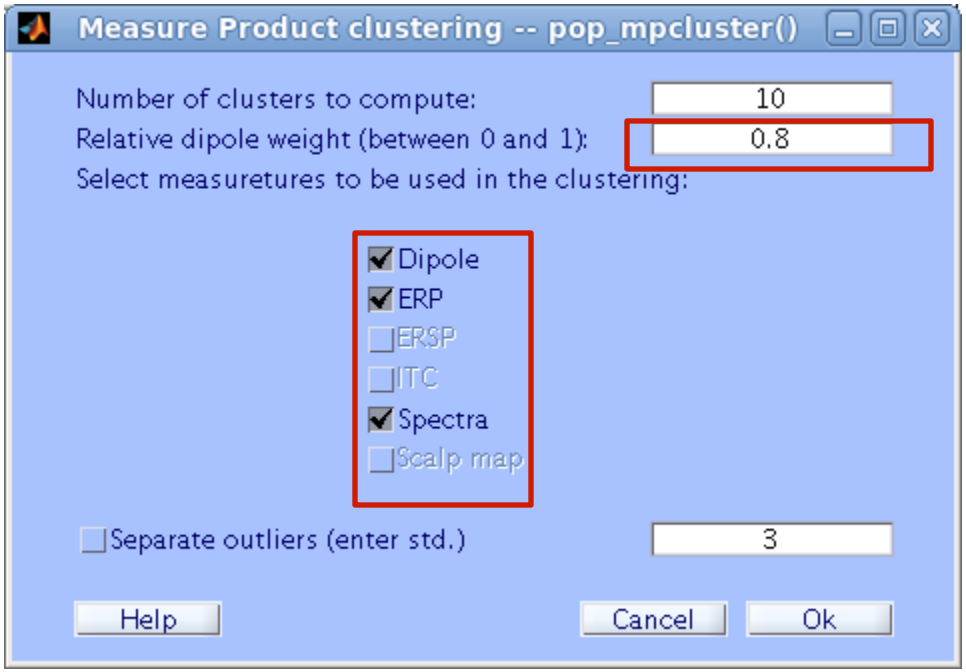




IC Clustering: Affinity Clustering

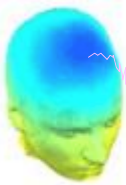
(EEGLAB plug-in by Nima Bigdely Shamlo)

only has one pre-clustering parameter.



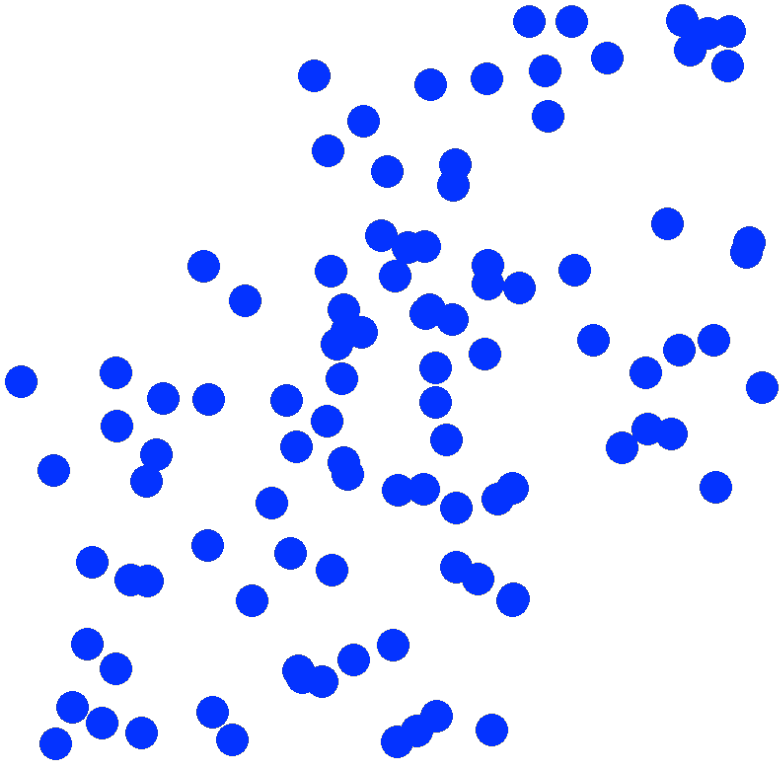
N. Bigdely-Shamlo, 2010

Problems with multi-measure clustering

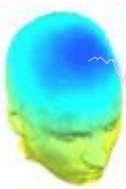


In a uniform density distribution,

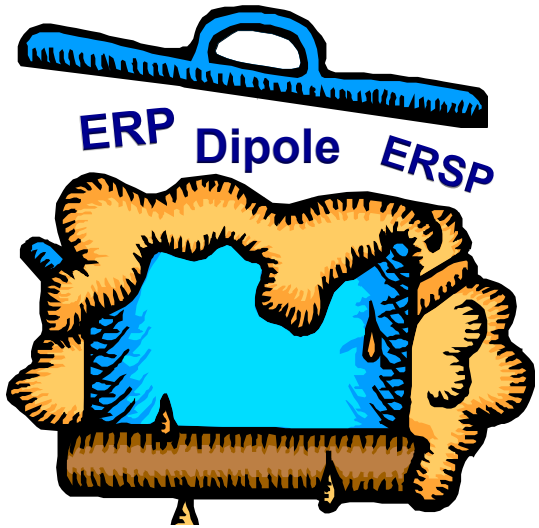
where are the clusters by location?



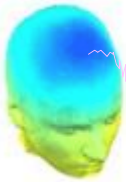
Study IC Clustering: New Approach



- With either clustering method, we basically mix together distances for a subset of EEG measures (ERP, ERSP, ITC, mean spectrum, dipole location).
- This may make clustering distance less interpretable.



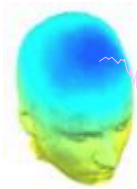
Study IC Clustering: Measure Projection



- **Instead**, we can directly work on pair-wise similarity matrices and prevent ICs with similarities less than certain threshold (e.g., ERSP corr. < 0.5) to be clustered together.
- The most important measure is **equivalent dipole location**.
- Assuming a certain variability estimate for dipole location (due to error in localization and subject variability), one can also estimate an optimum number of clusters.

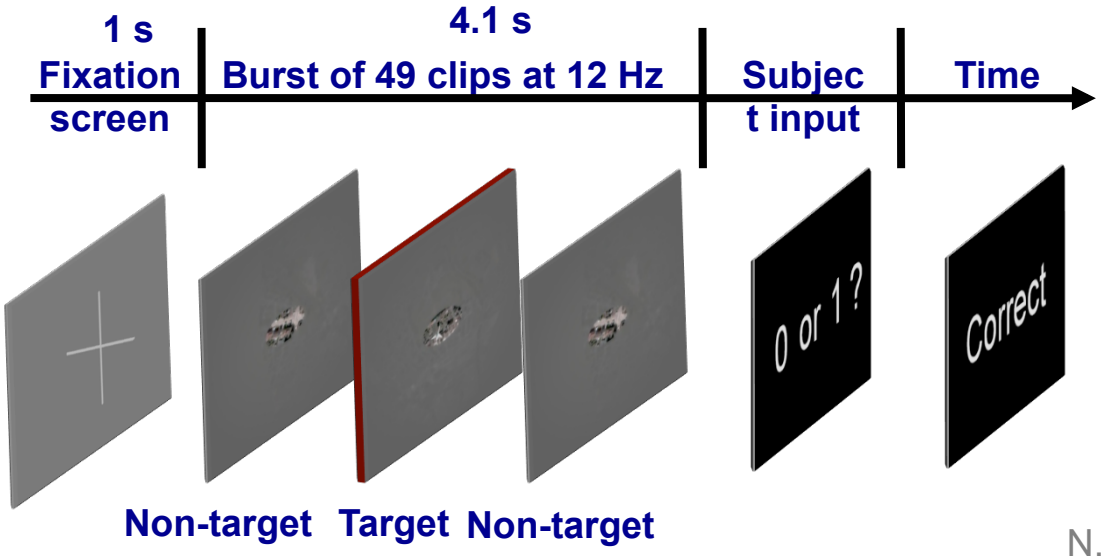
Measure Projection

Measure Projection: RSVP Example



Rapid Serial Visual Presentation Experiment

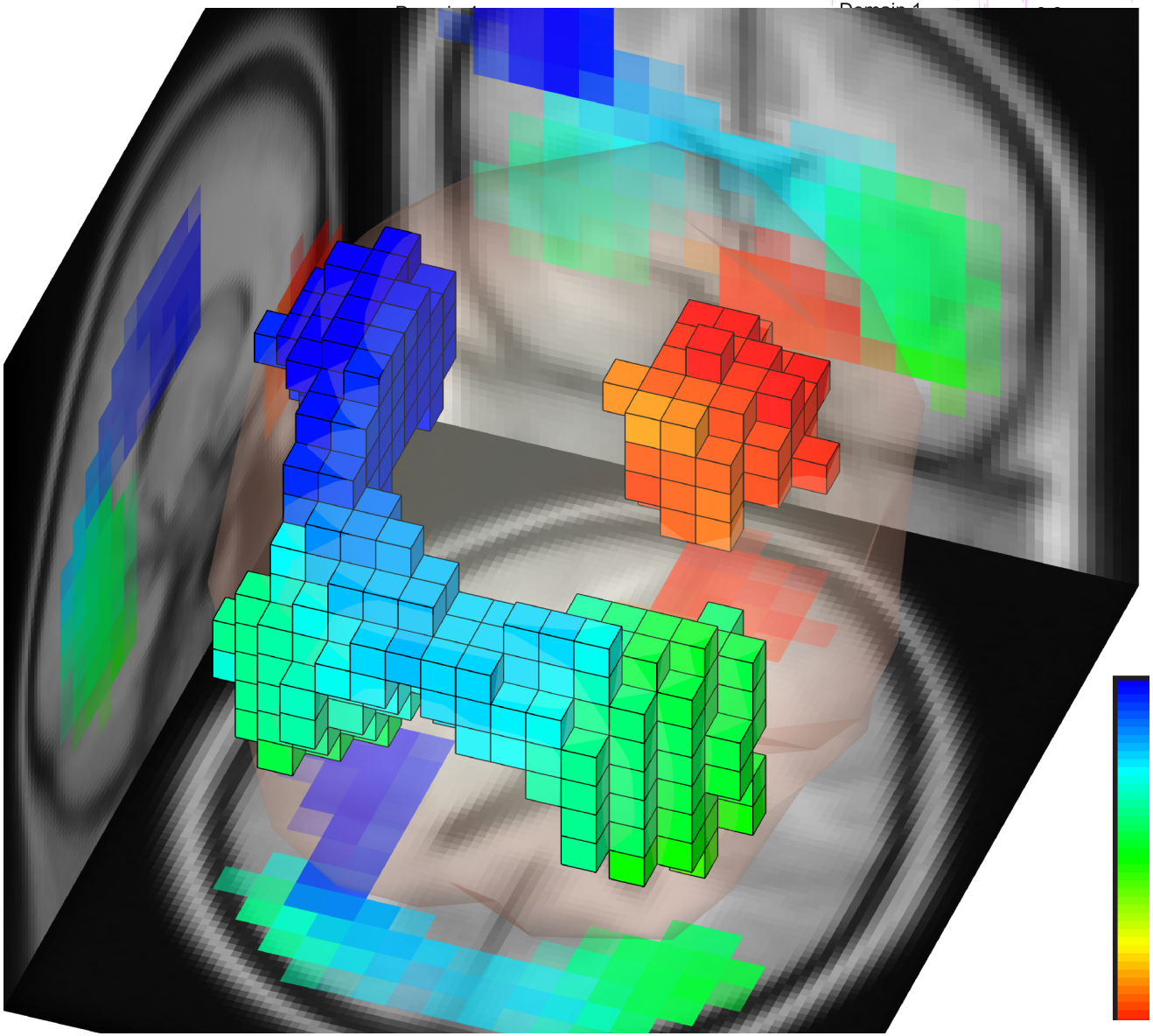
- 8 subjects
- 15 Sessions
- Visual target detection
- 257 components with equiv. dipoles inside the brain



N. Bigdely-Shamlo, 2010

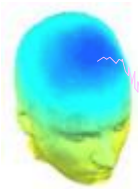
Measure Projection: RSVP Example

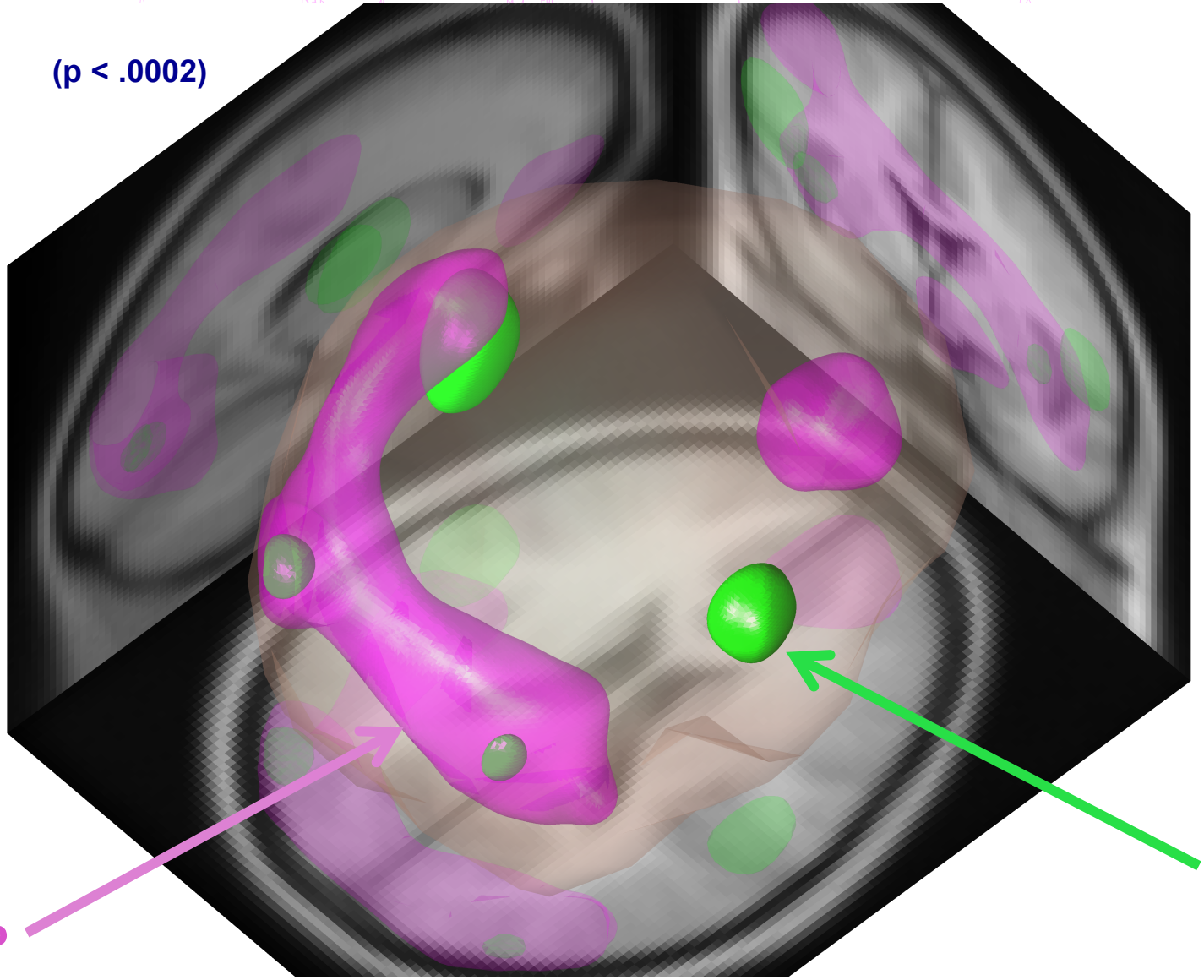
Project Target ERSPs on Equivalent Dipole Locations



N. Bigdely-Shamlo, 2011

Measure Projection: RSVP Example





N. Bigdely-Shamlo, 2011

Questions?